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ABSTRACT

In "The Sound Pattern of English," Chomsky and Halle maintain that the phonetic representation of most words can be generated from underlying forms and a small set of rules. Since these underlying forms are frequently close to the traditional spelling, we may hypothesize that literate native speakers share comparable internalized rules which enable them to agree on the pronunciation of new words. Twenty subjects were asked to pronounce 30 little-known English words. Because Chomsky and Halle's rules are based in part on learned Latinate vocabulary, the words were evenly divided between those entering English from Latin Greek, and Germanic sources to test for diffe-ences in performance relative to word origin. While the subjects averaged 81 percent agreement on stress assignment, the number of segmentally distinct responses ranged from one to ten per test word with an overall average of five. On the other hand, a majority of the subjects agreed in their pronunciation of 21 of the 30 words. The subjects demonstrated even more agreement in their interpretation of vowel graphemes under the same conditions of stress and syllable type. Chomsky and Halle's system reflects a fair degree of psychological reality, but it exceeds our competence on many points. (Author/CLK)

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ON THE PSYCHOLOGICAL REALITY OF UNDERLYING PHONOLOGICAL REPRESENTATIONS

In The Sound Pattern of English Chomsky and Halle maintain that the phonetic representation of most English words can be generated from abstract underlying phonological representations and a small set of rules. They further maintain (49) that conventional orthography is 'a near optimal system for the lexical representation of English words', since their underlying forms are frequently very close to the orthography. For example, aristocracy has the underlying phonological representation /aristo+crat+y/ which differs from the orthography only in that there is a /k/ for the c and the presence of two formative boundaries (131). Given this similarity of symbolization between orthographic and underlying forms, an indication of the psychological reality of Chomsky and Halle's system may be gained by testing literate native speakers on their pronunciation of unknown words. If Chomsky and Halle's Underlying Phonological Representations are psychologically real, rather than just a reflection of the history of English and descriptive linguistic convenience, then native speakers should show a high degree of consistency in their responses to the same orthographic stimuli; that is, they should agree on the pronunciatior of unknown words. This would indicate that the speakers share an internalized set of rules which operate on conventional orthographic representations. The degree of psychological reality of Chomsky and Halle's system should be reflected, then, by the amount of agreement between speakers and between the speakers and the rules. Where the speakers and the rules produce the same phonetic representations, the psychological reality of Chomsky and Halle's system is supported. Where the speakers agree with each other but not with a particular rule,

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the psychological reality of rules and underlying representations is still supported, because agreement indicates rule-governed behavior. Of course the reality of the particular rule is then in doubt. Where speakers do not agree, either there is no shared internalized rule or the stimulus is susceptable to the application of different rules.

In comparing the conventional orthographic system with its 26 letters to Chomsky and Halle's underlying system with its 48 segments, minus-rule features, and three distinct morpheme-boundary markers, it is hard to imagine that the orthography could be 'a near optimal system for lexical representation' (49). And yet much that is explicit in the Chomsky and Halle system is implicit in the orthography as seen by the literate native speaker. In interpreting the spelling she brings to bear her knowledge of English morphology, phonotactics, and orthographic conventions, such as the silent e, which serves about 15 different functions with respect to the morphology and pronunciation of English words (Schane). Although the differences between the orthographic and underlying systems are not as great as they may seem, the fact still remains that the Chomsky and Halle system is unambiguous while the orthography is frequently ambiguous.

A great deal of the ambiguity may be traced to the fact that stress and vowel tenseness are not clearly indicated in the spelling system. Underlying vowels are marked for tenseness; and the tense-lax feature plays an important role in stress assignment, vowel quality and vowel reduction. In the orthography words such as (1) ácaleph, (7) mèlanósis and (25) agée may also be interpreted as [əkéylef], [məlánəsəs] and [éyǰiy], where shifting stress causes different realizations of one or more vowel segments. In spite of this apparent orthographic ambiguity concerning stress placement, native speakers demonstrated a surprising

amount of agreement on stress assignment in the 30 test words. As I reported in an earlier paper, 'The Psychological Reality of Underlying Forms and Rules for Stress', the subjects agreed on the placement of primary stress 87.1% of the time and on the overall stress contour of each word 75.2% of the time. Twelve words evoked 95 to 100% agreement on primary stress: (3) eléntic, (7) mèlanósis, (9) périsàrc, (12) cunctátion, (13) fastígiàte, (21) láveròck, (22) písmìre, (23) rámson, (24) rígsdàler, (27) táfferel, (28) thírlage, and (29) wáppenschàw. Six of these had 95 to 100% agreement on the overall stress contour: (7) mèlanósis, (9) périsàrc, (21) láveròck, (22) písmìre, (23) rámson, (29) wáppenschàw. Apparently, morphological, phonological and orthographic clues greatly reduce the ambiguity of the orthography with respect to stress. But even under a single stress contour the orthography lends itself to diverse interpretations with respect to vowel and consonant segments, e.g., (1) acaleph [ækəlèf ákəlèf æsəlèf] and (16) piceous [páysiyəs písiyəs píšəs]. On the other hand, the segments may be identical under different stress patterns, e.g., (11) cernuous [sérnuwəs] and [sərnúwəs].

Despite these ambiguities, it is possible that the native speakers share internalized rules which operate on sequences of graphemes and morphological information which will more readily suggest one phonetic representation for a particular orthographic representation. This may be more true of certain lexical categories than others. As Chomsky and Halle (174) have pointed out, words of Greek, Latin and Germanic origin are treated differently with respect to certain rules; and since many of Chomsky and Halle's rules are based on learned Latinate vocabulary, speakers might show more agreement on such words.

Method

Subjects. The Ss were ten undergraduate and graduate students and ten Ph.d.'s from philosophy, foreign languages, history and English. All were native speakers of English. None had read The Sound Pattern of English.

Materials and Procedures. Thirty words were chosen from Webster's New World Dictionary of the American Language. Ten of these words were learned Latinate borrowings which had not been borrowed from Greek into Latin; ten were learned Greek borrowings which had not gone through Latin; and the remaining ten came from Anglo-Saxon, Danish, or English Dialects, all of which are Germanic. This was done to have three groups of words whose phonological, and therefore graphemic, structures would be as different as possible in order to test for variations in performance relative to these factors. The ends of words from Latin and Greek are frequently recognizable as derivational suffixes. This is a characteristic of those languages and is probably an important part of the input for their phonetic interpretation. Due to the difficulty of finding any rare verbs from Germanic sources, all the words were nouns or adjectives.

Each word was presented in a short sentence to indicate the part of speech, since this may be relevant to the location of stress and thus the phonetic interpretation, e.g., It's an acaleph, The pismire left, The roof was fastigiate. The Ss were told that all of the unfamiliar words on the page came from an English dictionary and that they were not marked as being foreign. The Ss were asked to read each sentence silently and then to pronounce the unfamiliar word. Each S was asked if she or he had previously learned the pronunciation of any of the words by hearing it used or looking it up. When this was the case, the response was not counted. But if the S had only seen the word before, it was assumed that her response

reflected her internalized rules. The 20 Ss were recorded and the final response for each test item was transcribed in a broad phonetic notation.

In compiling the results, responses in which sounds were omitted, added, or transposed, vis-a-vis the orthographic stimulus, were not counted, e.g., [bátrɔ̀yd] and [bátəriyɔ̀yd] for (2) bótryoìd; [əpáldədàk] for (8) ɔ̀podéldoc.

Results and Discussion

The number of segmentally distinct responses per word (excluding differences between unstressed [ɨ i ə u uw] and differences in stress contours) ranged from one (23) rámson to ten (18) rémigès with an overall average of five. By source languages, the average number of segmentally distinct responses were: 4.7 for Greek, 5.9 for Latin and 4.5 for Germanic. The higher average for Latin would suggest that speakers share fewer rules for interpreting words from this source, although the Chomsky-Halle system handles them fairly well. There was also less agreement on stress assignment for the Latin words than for the Germanic or Greek ones, although the differences were not statistically significant. The average number of syllables for each set of words was: Greek 3.5, Latin 3.2, Germanic 2.5; apparently, word length was not the cause of the higher number of distinct responses for Latin.

Five of the words evoked only three distinct responses: (7) mèlanósis [mèlənówsəs mèlənówsəs məlánəsəs]; (9) périsàrc [pérəsàrk pèrəzárk pìrəsárk]; (12) cùnctátion [kəŋktéyšən kəŋtéyšən səŋktéyšən]; (25) sílləbùb [sílləbəb səlábəb silæbəb]; and (27) táfferel [tæfərəl tæfərèl təférəl].

Some examples from the 24 words with four to ten responses are: (8) ɔ̀podéldac [àpədéldak ɔ̀wpədéldak əpádəldàk]; (10) petásos [pətásəs pétəsɔ̀ws pətásəs pətásows pítəsəs]; (16) píceous [páysiəs píysiyəs páykiyəs písiyəs píšəs pikéyows]; (18) remiges [réməǰìyz rémiǰəz réməgəz rəmíǰiyz

rəmáyǰəz rəmáǰəz ˌrəmígəs rəmíyzəs]; (26) agée [əǰiy əgíy ažíy àgíy éyǰiy àgíy áǰi]. Although much of the diversity in the interpretation of vowel graphemes can be ascribed to different stress contours, even under the same contours there are many differences. And there was an average of 75.2% agreement on the stress contours. The consonant letters c and g were also diversely interpreted.

Looking at the number of different responses per item, however, conceals a good deal of consistency in the responses. If we look instead at the number of subjects who agree on a single pronunciation (again excluding differences between unstressed [ɨ i ə u uw] and between tertiary and unstressed vowels of the same quality), we find that there is usually one response which a majority of the subjects favor. In fact this is true of 19 of the 30 test items. In two other cases, where the dictionary lists alternate pronunciations, a majority agreed on two pronunciations: (13) fastígiate [fæstíǰièt] (3 Ss) or [fæstíǰiət] (6 Ss) and (16) píceous [páysiyəs] (4 Ss) or [písiyəs] (5 Ss). Of the nine remaining test words with less than 50% agreement, three words ((11) cérnuous, (15) páludism and (17) rebóant) had at least 45% agreement on one pronunciation. Only six words, then, failed to get a consensus of sorts: (8) òpodéldoc, (14) óppidan, (18) rémigès, (24) rígsdàler, (25) agée, and (30) besprént.

Ignoring the dialectal and stylistic differences between unstressed [ɨ i ə u uw] and between tertiary and unstressed vowels of the same quality and between unstressed prevocalic [iy] and [i] as in [písiəs] vs. [písyiyəs], we see that the majority or near majority agreed with the prescribed pronunciation in 19 of 24 cases. In the other 5 cases the majority disagreed with the dictionary: (4) fòramínifer with [fòwrəmínəfər] instead of [fárəmínəfər]; (5) hegúmen with [hégyuwmən] instead of [higyúwmən];

(6) inósitàl with [inásətɔ̀l] instead of [inówsitòwl]; (17) réboant with [rəbówənt] instead of [rébowənt]; and (21) láverock with [lǽvərȁk] instead of [lǽvərək].

Although these results show a fair amount of consistency in S responses to the same orthographic stimulus, an examination of the responses to each grapheme in a particular environment reveals still more. In examining the responses to each vowel grapheme under three conditions of stress, in open and closed syllables (phonologically speaking) and initially, internally and finally, we find that in most cases a large percentage of Ss usually agree on a single phonetic interpretation in a particular environment. (Of course each grapheme did not occur under all these conditions in our corpus.) When a sequence of graphemes coincides with a derivational morpheme, such as in -ic, -ous, -ate, -ism, -al, there is almost 100% agreement. For this reason, the graphemes in such suffixes were not included in the count.

The letter a under primary or tertiary stress is overwhelmingly interpreted as [æ], except in two words: wáppenschàw where 15 of 20 Ss agreed on [ə] in the first syllable and in périsàrc where 19 of 19 did so, perhaps because of the [rk] cluster. Unstressed a is generally [ə] except in the initial closed syllable of fastígiàte, where it is [æ].

Under primary and tertiary stress the letter e is generally pronounced as [e], but 14 of 19 Ss used [é] before [r] in cérnuous. And the double e, stressed or unstressed, in agée was [iy] for everyone. When unstressed, the letter e is typically [ə], although six Ss pronounced it [iy] in eléntic and 16 did so in piceous, where we would expect tensing before another vowel.

The stressed letter i is generally [i] although before [r] in a closed syllable in thirlage it was [ə] for 18 out of 19 Ss; and in the

initial open syllable of piceous six Ss interpreted the i as [ˊ], six as [ˊy] and six as [ǽy], which demonstrates the ambiguity of i in that environment. In the open syllable of remiges, the Ss also split with 8 for [iy] and 4 for [i]. Under tertiary stress the grapheme i is typically interpreted as [i], except in písmìre, where 13 out of 17 Ss pronounced it as [ay] when followed by silent e. The unstressed letter i is predominantly [ə], but a majority of Ss preferred [i] in inositol and oppidan; and 17 of 18 Ss tensed the vowel to [iy] in the pre-vocalic position in fastigiate.

The letter o under primary stress is interpreted by the majority of Ss as [á] in the antepenultimate syllable of botryoid, inositol and and oppidan, and as [ów] in the penultimate syllable of melanósis and reboant. Under tertiary stress o is generally pronounced [ów] in an open syllable, e.g., fòramínifer, rébòant, and òpodéldoc (although about one half of the Ss also pronounced this as [àpədéldak]. In closed syllables o with tertiary stress is typically [a], as in opodeldoc [apədéldàk] and láverock [lávəràk]; however, the ten and twelve responses with tertiary stress on the final closed syllable of inósitòl and pétasòs agreed completely on the pronunciations [-ɔ̀l] and [-òws].

The letter u under primary stress is [ə] before n in a closed syllable, and [uw] elsewhere, as in úncinal, hegúmen and palúdism. Under tertiary or Ø stress u is [ə] in closed syllables, as in cùnctátion, síllabùb, ùncínal, and [yuw] or [uw] in free syllables, as in hégùmen and trábecùla.

The letter y in bótrylod was [iy] for all subjects; and the aw in wappenschaw was unanimously [ɔ̀].

Among the consonants only c and g posed any problems in interpretation. Basically, the letter c was pronounced [k] before [ə] and [yuw] or [uw] (acaleph, cunctation, trabecula), but 15 Ss used [s] before [ə] in cérnuous.

Apparently, the graphemes a, u and e tell the Ss whether it is [k] or [s] before [ə]. Before phonetic front vowels, the majority of Ss chose [s], as in piceous and uncinal. One to three Ss, depending on the word, violated these generalizations in each case and produced such forms as [ásəlèt], [čə́rnuwəs], [kérnuwəs], [píkiyəs].

A good majority of Ss interpreted the letter g as [ǰ] before the letters i and e and as [g] elsewhere (fastigiate, agee, remiges vs. hegumen, rigsdaler.) Again one to five Ss violated this rule and produced forms such as [fæstíǰiyèyt], [əǰí], [héǰuwmən]. Thirlage and remiges evoked six and three [ž]'s respectively: [θə́rlaž] and [rəmíyžəz].

Since many if not most of Chomsky and Halle's rules operate on underlying segments which are often far removed from their ultimate phonetic value and their orthographic representations, it is not possible to directly compare the two systems. On the other hand, some of the rules either put constraints on possible phonetic representations or are based on certain regularities which, however, are not inviolate. These underlying constraints and regularities, if they are psychologically real, should be reflected in the data.

The rule which laxes stressed vowels before unstressed nonfinal syllables is a generalization which most Ss followed. Although the dictionary pronunciation for inositol violates this rule with tense [ow], only two of the 16 Ss who stressed this syllable pronounced it [ow]. The rest used [a], which the rules would predict, because it is lax /ɔ/ in its underlying form. The dictionary violates the laxing rule with a tense vowel in piceous [páysiyəs] but adheres to it in the alternate pronunciation [písiyəs]. Twelve of 18 Ss also violated the rule by using tense [iy] or [ay].

The rule which tenses pre-vocalic non-low vowels in Chomsky and Halle's dialect is violated by the dictionary with [fæstíǰièt] and [fæstíǰiit] for fastigiate and also in piceous with the final sequence [-iəs]. The Ss, however, almost unanimously followed the rule here and in cérnuous and réboant.

The rule of velar softening for underlying /k^d/ and /g^d/ was followed by most of the Ss most of the time, but not always. The rule which voices /s/ between a tense vowel and another vowel, as in music, was not followed in [inówsitɔ̀l], [mèlənówsəs], [pətówsəs], [pfysiyəs]. Chomsky and Halle admit that there are many exceptions to this rule (228).

Conclusion

In view of the fact that the majority of the Ss agreed as much as they did in their pronunciation of the test words and in their interpretation of the graphemes, we would have to say that the Chomsky-Halle system has a fair degree of psychological reality. The Ss apparently do share a number of internalized rules which are accounted for by the formal rules. On the other hand, the diversity of the responses to many of the words belies Chomsky and Halle's claim (49) that the conventional orthography is a 'near optimal system for the lexical representation of English words', at least for native speakers. While the orthography may be 'near optimal' for a system of underlying representations and formal rules, the speakers' competence or internalized rules are not nearly so well defined or consistently applied; and if the Ss shared exactly the same rules and categories for the pronunciation of unknown written words, they would not always agree on the same phonological and morphological input, because the orthography is often ambiguous on these points. The Chomsky-Halle system far exceeds our competence in this area because its input is unambiguously specified phonologically, morphologically, and categorically.

Table 1. Words of Greek Origin

Dictionary	No. of Different Responses	Most Frequent Response	No. of Ss	Typical Minority Response
1. acaleph [ǽkəlef]$_N$	7	[ǽkəlèf]	10/20	[əkéyləf]
2. botryoid [bátrìɔyd]$_A$	4	[bátriyɔ̀yd]	8/14	[bówtriyɔ̀yd]
3. elenctic [iléŋktik]$_A$	7	[əléŋktik]	10/19	[iyléŋktik]
4. foraminifer [fàrəmínəfər]$_N$	4	[fɔ̀wrəmínəfər]	15/20	[fowrámin'ifər]
5. hegumen [higyúwmən]$_N$	6	[hégyuwmən]	10/20	[héguwmən]
6. inositol [inówsitɔ̀wl]$_N$	5	[inásitɔl]	11/20	[inásətəl]
7. melanosis [mèlənówsis]$_N$	3	[melənówsəs]	18/20	[məlánəsəs]
8. opodeldoc [àpowdéldak]$_N$	5	[àpədéldak] 5/18 [ɔ̀wpədéldak] 5/18		[əpádəldàk]
9. perisarc [pérəsàrk]$_N$	3	[pérəsàrk]	18/20	[pérəzàrk]
10. petasos [pétəsəs]$_N$	7	[pétəsɔ̀ws]	6/20	[pətásəs]

Table 2. Words of Latin Origin

Dictionary	No. of Different Responses	Most Frequent Response	No. of Ss	Typical Minority Response
11. cernuous [sórnyuwəs]$_A$	6	[sórnyuwəs]	9/19	[sórnuwəs]
12. cunctation [kəŋktéyšən]$_N$	3	[kàŋktéšən]	12/19	[səŋktéyšən]
13. fastigiate [fæstíǰièyt]$_A$ [fæstíǰiit]$_A$	6	[fæstíǰiyèyt]	3/18	[fæstígiyèyt]
		[fàstíǰiyət]	6/18	
14. oppidan [ápidən]$_{NA}$	6	[ápədən]	7/20	[ówpidàn]
		[ápidàn]	6/20	
15. paludism [pælyuwdizm]$_N$	5	[pæluwdizm]	9/20	[pəlúwdizm]
16. piceous [páysiəs]$_A$ [písiəs]$_A$	7	[páysiyəs]	4/18	[písiyəs]
		[písiyəs]	5/18	
17. reboant [rébowənt]$_A$	4	[rəbówənt]	9/19	[rébowənt]
18. remiges [réməǰìyz]$_N$	10	[rəmíyǰəz]	6/19	[réməǰəz]
19. uncinal [ánsinəl]$_A$	5	[ánsənəl]	10/18	[ànsínəl]
20. trabecula [trəbékyuwlə]	7	[trəbékyuwlə]	11/20	[trèbəkúwlə]

Table 3. Words of Germanic Origin

Dictionary	No. of Different Responses	Most Frequent Response	No. of Ss	Typical Minority Response
21. laverock [lǽvərək]$_N$ / [léyvrək]$_N$	6	[lǽvərȁk] / [léyvrȁk]	10/20 / 3/20	[lǽvərək]
22. pismire [písmȁyr]$_N$	5	[pízmȁyr]	9/17	[píyzmȁyr]
23. ramson [rǽmsən]$_A$	1	[rǽmsən]	20/20	
24. rigsdaler [rígzdȁlər]$_N$	4	[rígzdȁlər]	8/20	[rígzdèlər]
25. sillabub [síləbȁb]$_N$	3	[síləbɔb]	15/17	[siláb$\breve{\text{ɔ}}$b]
26. agee [əǰíy]$_A$	7	[əǰíy]	5/20	[éjiy]
27. tafferel [tǽfərèl]$_A$ / [tǽfərəl]$_A$	3	[tǽfərèl] / [tǽfərəl]	4/20 / 15/20	[təférəl]
28. thirlage [θérliǰ]$_N$	5	[θérliǰ]	10/19	[θérlàž]
29. wappenschaw [wápənšɔ̀]$_N$	4	[wápənšɔ̀]	14/19	[wápənšɔ̀]
30. besprent [bisprént]$_A$	7	[bésprənt]	4/19	[bəsprént]

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